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(NASA-CR-194705) DUST CONTENT OF A HYDROGEN RICH, LOW SURFACE BRIGHTNESS GALAXY AND THE LUMINOSITY HISTORY OF 3C273 Annual Status Report, 1 Sep. 1992 - 31 Aug. 1993 (Columbia Univ.) 5 p

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One of the more controversial objects discovered recently by astronomers is the large clooud of neutral hydrogen gas detected by Giovanelli and Haynes (1989) in the general direction of the Virgo cluster of galaxies. The object is unusual because it contains an enormous mass of hydrogen, 10^{10} solar masses, and yet appears to have very few stars. That is, the mass of hydrogen, for some reason, has been not undergoing the normal star formation processes which create normal galaxies. Giovanelli and Haynes origianlly proposed that the object may represent a primordial galaxy which has, in some way, survived into the present epoch, and could serve as a laboratory to test models of galaxy formation. This would be tremendously useful because, of course, galaxy evolution theory continues, despite serious efforts by many workers, to be obdurately inchoate. The early optimism about the importance of the object was dimmed considerably by Impey et al. (1990) who pointed out that the redshift of the object, readily measured in the 21 cm line, was not a reliable distance indicator because of the influence of the nearby Virgo cluster, the virgocentric infall. The resulting confusion has left the relevence of the object to galaxy formation in doubt. Nevertheless the object remains important both in itself and, because it is an unusually large concentration of neutral gas far from any known sources of ionizing flux, as a probe of conditions in the intergalactic medium far from any large galaxy.

In particular, this observation was scheduled to attempt to detect the light echo from the 3C273 in the GH cloud. If the cloud has a gas to dust ratio no more than ten times the galactic value, we should be able to see X-rays emitted from 3C273 which have specularly reflectied of the sides of dust grains in the cloud. Because the arrival time of reflected light will be delayed from the arrival time of light coming to the solar system directly from 3C273, the intensity of the reflection over the face of the cloud will measure the variation in inherent luminosity of 3C273 over a period

of 50,000 years, thereby extending the time scale on which the objects light curve has been studied by over three orders of magnitude. 3C273 has a viscous timescale on the order of a few thousand years, which is also approximately tghe light crossing time of the jet. We therefore expect that the project will open a new window into the physics of AGN. As we discuss below, we have made a serendipitous discovery of potentially great importance to the history of star formation, but which has unexpectedly complicated our attempt to measure the light curve.

This project consists of a 30,000 second PSPC observation of the Giovanelli-Haynes Cloud in an attempt to detect light emitted by 3C273 which has been reflected by the cloud, and incidentally seach the cloud for other source of X-ray emission. The observation was carried out by *ROSAT* on Dec. 25, 1992 and the data was received by the P.I. in late March of 1993. We have examined the data and determined that the observation's background level, astrometry, etc. are acceptable. We have also detected diffuse emission from the direction of the Giovanelli-Haynes Cloud. Determination of the origin of this emission, by examining its morphology in relation to that of the radio map and the object's geometric relation with 3C273 requires software implemention of specialized algorithms.

However, the most dramatic observation in the field is a potentially new population of discrete soft X-ray sources associated with dwarf galaxies. The optical counterpart to the GH object is a small, very blue, low-metallicity dwarf galaxy. This object seems to have a collection of X-ray sources associated with it. An ellipse 10×20 minutes on a side, centered on the blue optical source (which is itself only about 3 minutes across) and with its major axis along the major axis of the HI cloud contains all of the gas which is at the same velocity as the blue stars and the ten brightest X-ray sources in the field. The sources are quite soft, too soft to penetrate the cloud. The question is obviously whether the sources are physically associated

with the cloud or are background objects. They are not foreground objects; none are catalogued or have POSS counterparts. Based on their hard emission, they are only marginally significant, but the broad emission is more convincing. It is their soft emission that makes them stand out. The best argument that they are not an unusual agglomeration of background sources is their spectra which appear to be anomalously soft. Of the six objects coincident with cloud regions thicker than 10^{19}, four have hardness ratios $(A-B)/(A+B) < -.35$, of the 25 detected objects outside of the cloud only 1 is that soft and only 2 are softer than $-.2$. This doesn't sound like background AGN, especially AGN shining through about 10^{20} of galaxy plus cloud absorption. The morphology appears convincing intuitively, but such arguments can be severly misleading withouut sound statistical corroboration.

If the sources are associated with the cloud they have a luminosity of a few times 10^{38}, giving the whole object a luminosity of about 10^{40}. Comparing the X-rays to the optical $f_x/f_v = -1$ for the GH cloud as a whole, although f_x/f_v for each point source is certainly > 1. The striking thing about the object is that the mass of its gas is about 2.5 orders of magnitude more than the mass in stars. Its dynamical mass is about an order of magnitude more than its gas mass. See Salzer et al. *A.J.*, **101**, 1258 (1991). Of course, we wish to subtract these sources so that we can look for the reflection which was the original idea for the observation. But it is very important to determine whether they are background or not. If they are not background they would appear to be binary sources emitting X-rays at about the Eddington limit for a mass a little larger than solar. Indeed they all seem to have about the same luminosity. We can detect sources about five times fainter than the 10 objects in the cloud but the fainter sources are both more evenly distributed and much harder. The fainter sources also fall along the extragalactic $\log N - \log S$ for the hard band. Except for its huge cloud of gas, GH is similar to other dwarf

galaxies with very low metallicity and very blue colors. Several groups have searched dwarfs for X-ray sources without success. If the sources are associated with the GH cloud, and no other explanation for the anomalous spectra suggests itself, this is a major surprise. It adds new data to Griffiths and Padovani's X-rays vs. metallicity (or black holes versus metallicity) chart. We have performed a few other simple tests for variability etc., but gotten no signal (one of the ten is variable at the 90% conf. level). Each source has a little over a hundred photons so further analysis of the X-ray data is not important. We have arranged to use the Palomar 200 inch to perform optical follow-up in the spring. The detection of these bright sources in such a low-metallicity dwarf galaxy, while not exactly unsuspected, will greatly clarify our ideas about the evolution of galaxies, the evolution of the chemical elements, the abundance of black holes, and the nature of the intergalactic ionizing flux.